

Hanging a sculpture

- You are part of a team to help design the atrium of a new building. Your boss, the manager of the project, wants to suspend a 20-lb sculpture high over the room by hanging it from the ceiling using thin, clear fishing line (string) so that it will be difficult to see how the sculpture is held up. The only place to fasten the fishing line is to a wooden beam which runs around the edge of the room at the ceiling. The fishing line that she wants to use will hold 20 lbs (20-lb test) so she suggests attaching two lines to the sculpture to be safe. Each line would come from the opposite side of the ceiling to attach to the hanging sculpture. Her initial design has one line making an angle of 20° with the ceiling and the other line making an angle of 40° with the ceiling. She knows you took physics, so she asks you if her design can work.

Project

- Observe a tug of war.
- Draw a diagram of the system and all of the forces acting on the system, as well as the internal forces acting on the individual objects.
- Analyze and describe the system of objects in terms of forces.
- What are the internal forces?

Lesson #42

Topic: Tension

Objectives: (After this class I will be able to)

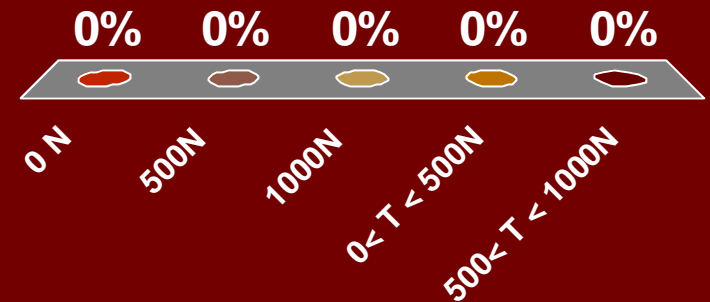
1. Define Tension
2. Find the tension in a string, rope, or cord within a system of objects.

Warm Up: Two teams are in a tug of war. Each team pulls with a force of 500N. What is the tension in the rope?

Assignment: "Concept Development 4-2" due Monday

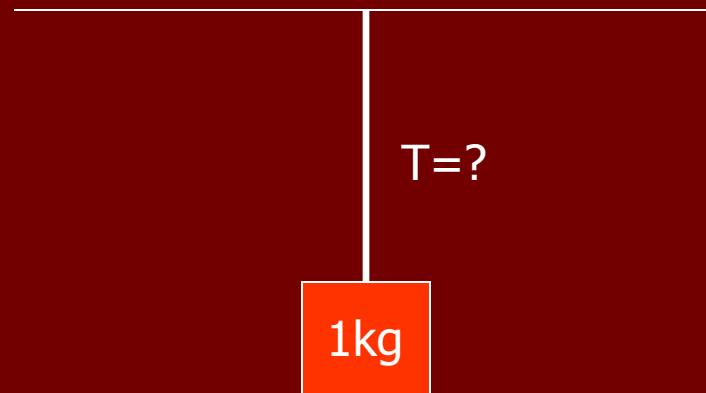
Two teams are in a tug of war. Each team pulls with a force of 500N. What is the tension (T) in the rope?

1. 0 N
2. 500N
3. 1000N
4. $0 < T < 500\text{N}$
5. $500 < T < 1000\text{N}$



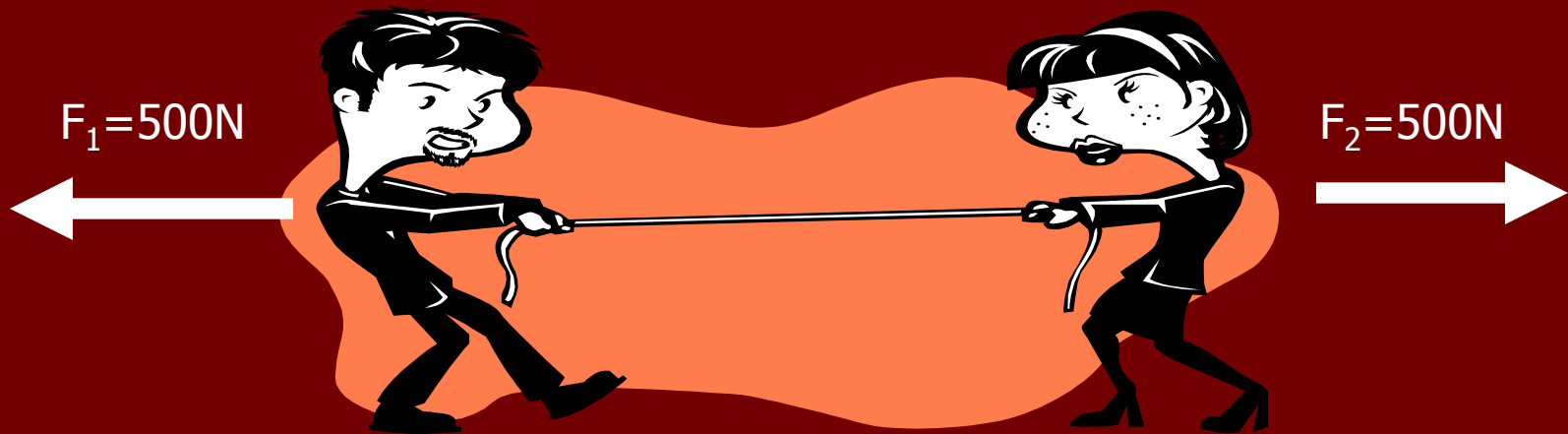
Tension

- Tension: A pulling force acted by a rope, cord, or string.
- Tension is just another force, that happens to be a rope instead of a push or pull by another object.



Tension

- Tension can only be found when analyzing one individual object.



Tension

- Looking at the entire system, one would guess the tension to be either zero or 1000N.
- But when you look at one object alone, it is easy to see that tension is an internal force and equal to 500N.

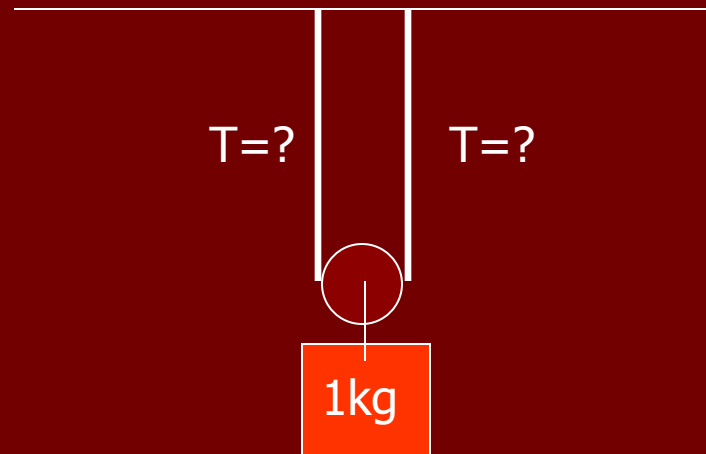


Tension



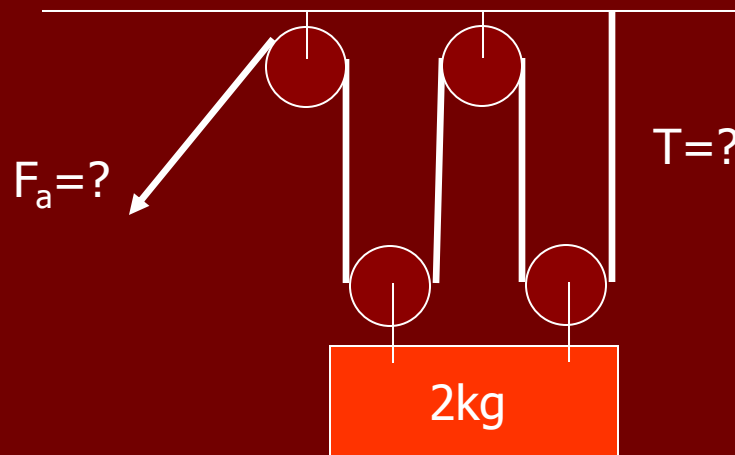
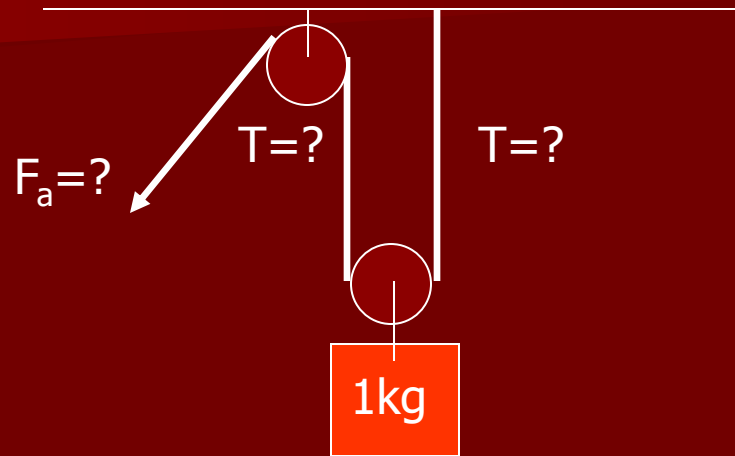
Tension

- Tension is slightly more complicated as more strings are used.
- Although this is one string used with a pulley, it can be treated as if it were two separate tension forces.



Tension Practice

- Find the tension in the following diagrams.



Hanging a sculpture

- Does the boss's design work?
- How do you prove to her that it'll be safe or not safe?

Lesson #43

Topic: Lab: Tension and Pulleys

Objectives: (After this class I will be able to)

1. Build a system of strings and pulley's to easily lift an object with less force.

Lab Question: How does tension in rope and pulleys allow us to use little force to lift very heavy objects?

Assignment: Tension Lab Report due tomorrow!

Ice Skating

- You are taking care of two small children, Sarah and Rachel, who are twins. On a nice cold, clear day you decide to take them ice skating on Lake of the Isles. To travel across the frozen lake you have Sarah hold your hand and Rachel's hand. The three of you form a straight line as you skate, and the two children just glide. Sarah must reach up at an angle of 60 degrees to grasp your hand, but she grabs Rachel's hand horizontally. Since the children are twins, they are the same height and the same weight, 50 lbs. To get started you accelerate at 2.0 m/s^2 . You are concerned about the force on the children's arms which might cause shoulder damage. So you calculate the force Sarah exerts on Rachel's arm, and the force you exert on Sarah's other arm. You assume that the frictional forces of the ice surface on the skates are negligible.



Lesson #44

Topic: Tension in an accelerating system

Objectives: (After this class I will be able to)

1. Analyze objects connected by a cord independently to solve for internal forces, net force, or acceleration.

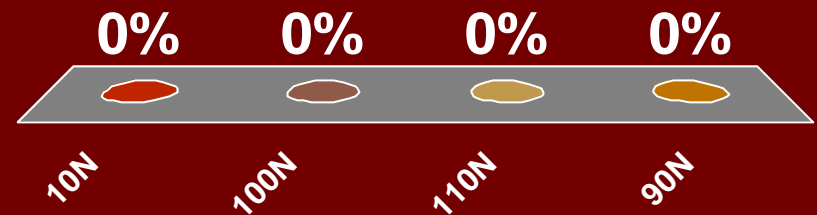
Warm Up: A 10kg mass attached to a rope is being pulled upward with an acceleration of 1m/s^2 . What is the tension in the rope?

Assignment: "Tension" due Monday.

A 10kg mass attached to a rope is being pulled upward with an acceleration of 1m/s^2 . What is the tension in the rope?

1. 10N
2. 100N
3. 110N
4. 90N

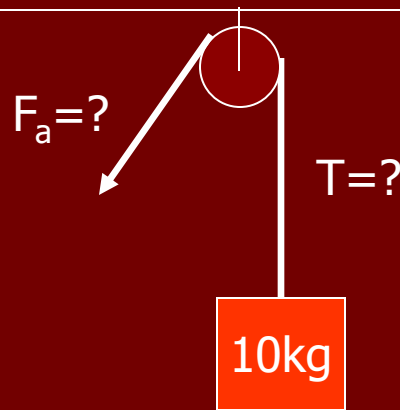
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of
20



Tension and acceleration

- Solve the same as a regular net force problem with acceleration.

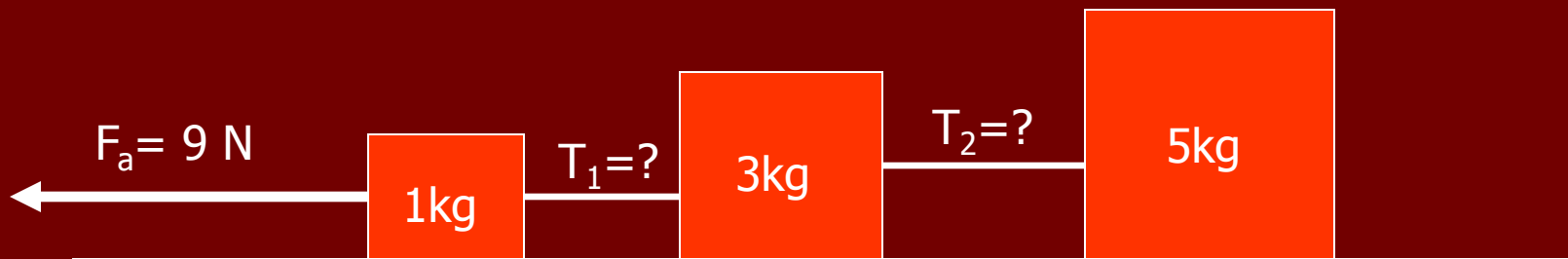
$$a = 1\text{m/s}^2$$



Tension in accelerating systems

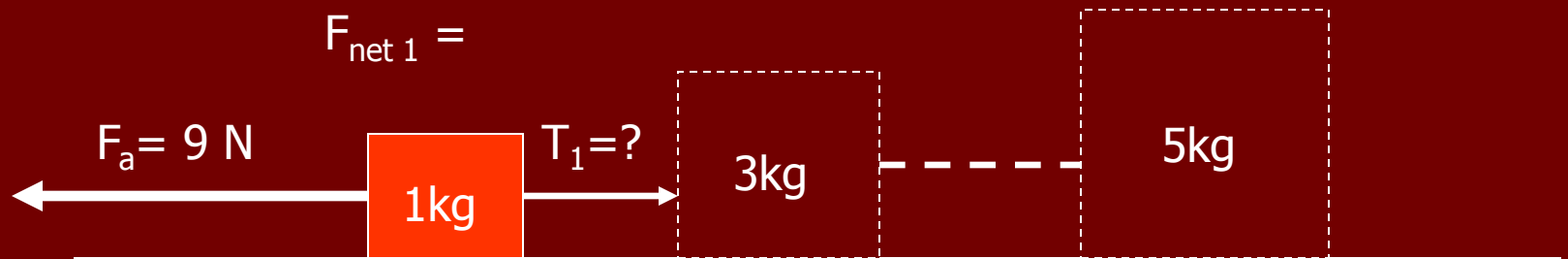
- These problems can be solved exactly as previous accelerating system problems.
- Just treat the tension as you would treat any other internal force.

$$F_{\text{net } 1} = \quad F_{\text{net } 2} = \quad F_{\text{net } 3} =$$



- Notice that there are two different tensions because there are two different cords.

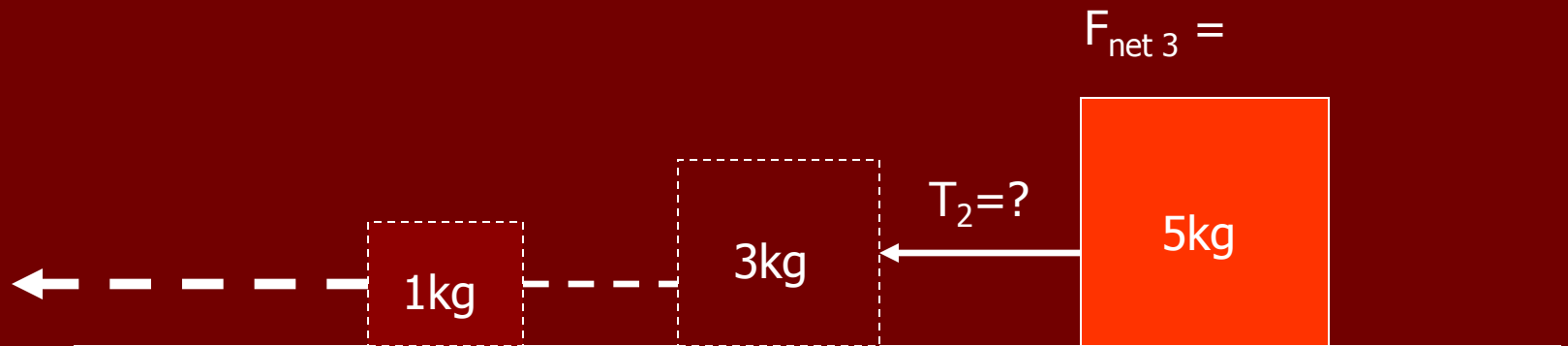
Tension in accelerating systems



Tension in accelerating systems



Tension in accelerating systems



Ice Skating

- Determine how hard you are pulling on the twins arms.
- Do you think this is a reasonable force or could possibly cause injury? Explain.